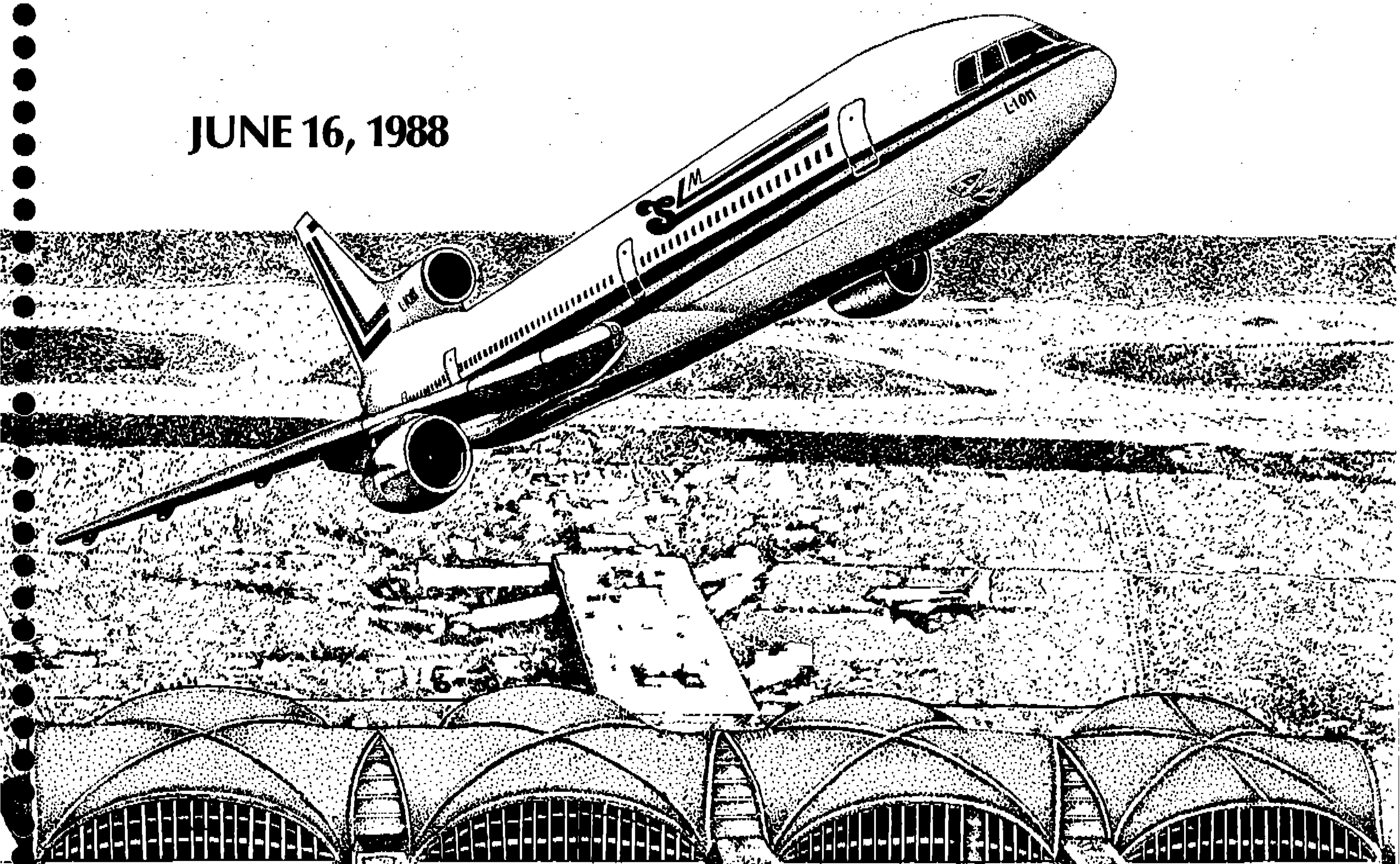
Lambert St. Louis
International Airport

Airport Capacity Enhancement Plan

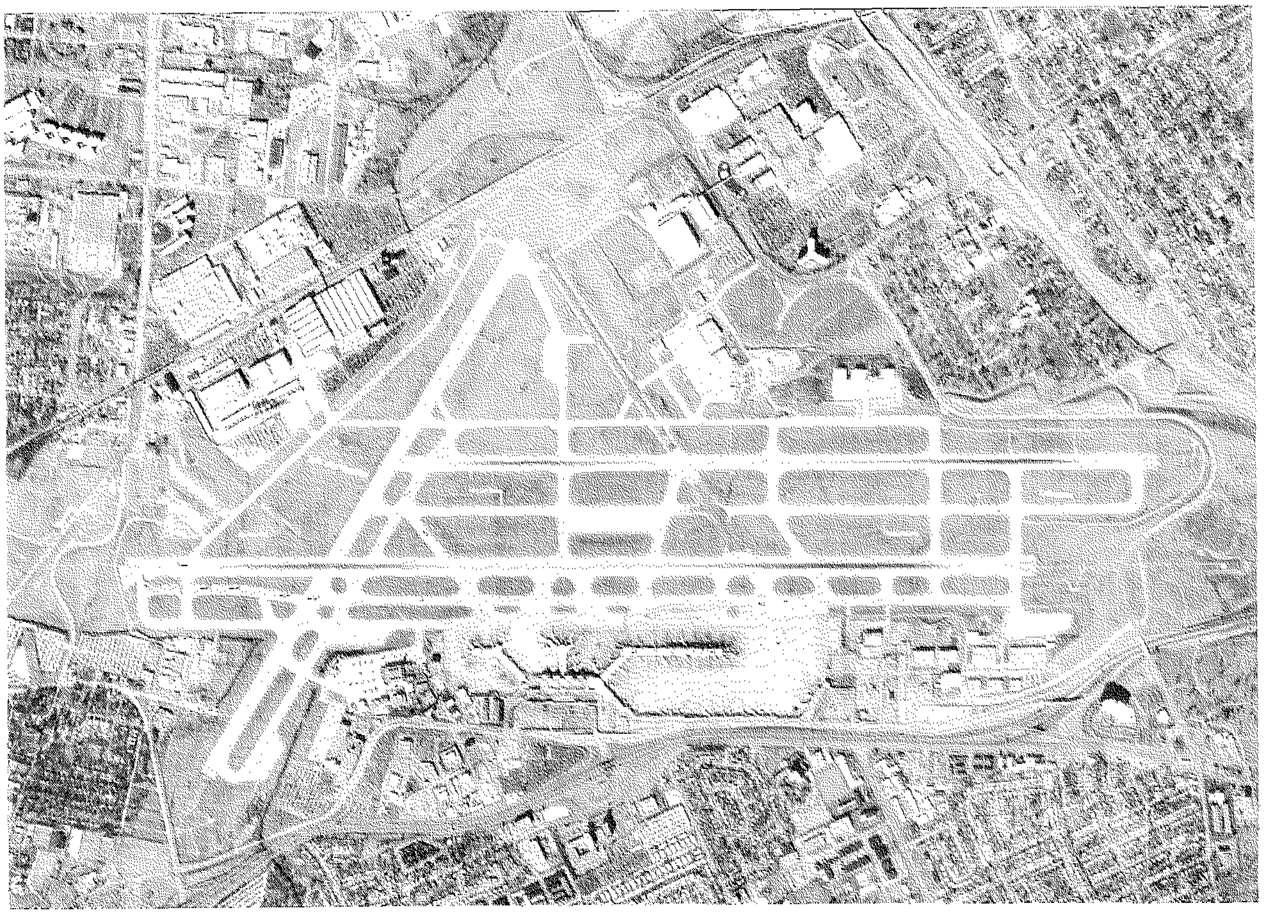
JUNE 16, 1988



PREFACE

The Task Force studied several alternatives for increasing capacity and reducing delays at the Lambert St. Louis International Airport. The FAA Technical Center Airport Technology Branch provided technical support for the study.

In particular, the St. Louis Task Force studied the conditions causing current delays, forecast future delays and evaluated various improvements for reducing aircraft delays and increasing airport capacity. These recommendations are intended to be acted upon by the appropriate agencies with support from other Task Force agencies. However, since all technical or procedural concerns may not have been fully addressed in this study, additional analysis will be required before the alternatives are implemented.



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Prepared jointly by the U.S. Department of Transportation Federal Aviation Administration, Lambert-St. Louis Airport Authority, Air Transport Association, the Airlines and General Aviation serving St. Louis

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INTRODUCTION

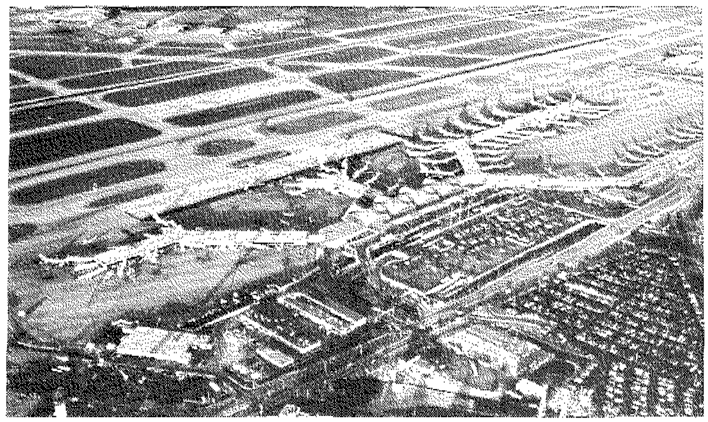
Background

The Lambert - St. Louis International Airport (STL) is one of the ten busiest airports in the United States.

More than ten million passengers enplaned at STL in fiscal year 1986. During this same period, the airport handled over 460,000 aircraft operations.

Delays at STL increase dramatically as the weather deteriorates. Hence improvement in IFR capacity to levels approaching those of the airport's VFR capacity is extremely important.

Nationwide, 70% of the delays are caused by adverse weather. Because of this STL needs to significantly increase the IFR capacity. The delays wasted millions of gallons of fuel, caused many hours of lost passenger time, increased airfield congestion and created additional problems for the Air Traffic Control and Air Transportation Systems.



Previous reports identified improvements to be implemented by the time certain traffic levels were reached if delays were to be forestalled or at least reduced. These benchmark traffic levels were then equated to a specific year using some method of traffic forecasting. Since traffic forecasting is at best an inexact science (traffic levels at St. Louis presently exceed all forecast levels through 1992), the task force chose to construct this report using only specified traffic levels as benchmarks without attempting to predict the year in which such traffic levels might be reached. Constructed in this manner, the document should retain its validity until the last benchmark is reached regardless of the rapidity with which each benchmark is attained.

These benchmarks were set: Baseline, Future 1, and Future 2. The annual traffic levels used as benchmarks resulted from a group consensus of what was realistically achievable provided appropriate improvements were accomplished. The baseline daily demand used in conjunction with the baseline annual demand (benchmark) was created by selecting a typical day's traffic (11/13/86) and adding 15%. This addition was to compensate for the increase in traffic during the heavy traffic season and projected traffic growth through 1987. Using the two baseline figures, the number of equivalent days (the number of daily demand replications required to achieve the annual demand) was determined. The daily demands for Future 1 and Future 2 were then computed using the number of equivalent days and their respective annual demands.

Based on data from its annual delay computer model, the Federal Aviation Administration (FAA) estimates that for a Baseline traffic level of 530,000 operations, each operation will be delayed an average of 18 minutes. This adds up to an annual delay of approximately 158,000 hours at a cost of $233 million. In this study, an operation is considered delayed if the flight time is over and above the scheduled operating time and the increase in time is caused by the interaction with other aircraft competing for the same facilities and airspace in the St. Louis area.

The study indicated many additional improvements will be necessary to meet Baseline demand and provide capacity for potential future growth.

The Task Force studied several proposals for increasing capacity and reducing delays. Those considered feasible are listed in figure 1 as "Recommended Options".

Objectives

The major objective of the St. Louis Task Force Study was to develop recommended options which if implemented would increase airport capacity, improve airport efficiency and reduce aircraft delays.

In addition to achieving this objective, the Task Force accomplished the following:

- Assessed current airport capacity and established the causes of delays associated with airspace, airfield, and apron/gate area operations.
- Evaluated capacity and delay benefits of alternative air traffic control (ATC) procedures, navigational improvements, airfield changes and user improvements.
- Examined the relationship between air traffic demand and delay that could be used as an aid in establishing acceptable air traffic movement levels.

Scope

The St. Louis Task Force limited its analyses to aircraft activity within the terminal area airspace and on the airfield. It considered improvements that could increase capacity and reduce delays.

The Task Force realizes that there are groundside and environmental considerations, which are beyond the scope of its charter, that will be addressed by further study in future airport planning. The data developed in this study will provide important inputs to these future studies.

Methodology

The FAA used two computer models to study improvements proposed to enable STL to accommodate anticipated future traffic demands. Appendix A contains a discussion of the Airfield Delay Simulation Model (ADSIM), the Runway Delay Simulation Model (RDSIM), and the methodology used.

Participants

At the start of this study, the Task Force chairman, Roland Elder of the FAA, asked every group having an interest in reducing delays, increasing capacity and improving efficiency at STL, to provide a representative to work on the study.

Those who participated are Donald Bennett, Bernie Hartman, Ray Freund, Tom Richter, Jim Brown of Lambert - St. Louis Airport Authority; Richard White of Air Transport Association; Lloyd Parr of Missouri Highway and Transportation Department/Aviation; Garred Jones, Terry Schaddel, of Illinois Division of Aeronautics; Ron Moore of Trans World Airlines; Joe Lintzenich of Wetterau Inc./NBAA, National Business Aircraft Association; Jan Titus, Thomas Cronin, Gene Olson of East-West Gateway Coordinating Council; Robert Yatzeck, Duane Thomas, Lloyd Gilworth, Roger Wall, William Buck, Edward Thompson, Bill Horstman, Bob Lindsey, John VanderVeer, Robert Holladay, and Babulal Shah of FAA.

RECOMMENDED OPTIONS AND ANNUAL SAVINGS

IMPROVEMENTS	Type of Action *1	Time Frame *2	Responsible Agency	Estimated Construction Costs 1987 Dollars (Millions)	ANNUAL SAVINGS IN THOUSANDS OF HOURS			ANNUAL SAVINGS IN MILLIONS OF 1987 DOLLARS		
					Baseline	Future 1	Future 2	Baseline	Future 1	Future 2
AIRFIELD IMPROVEMENTS										
(1) New Runway Parallel to RWY 12L/30R	Master Plan	Intermediate Term	Airport Authority							
(1a) Alternate 1: New Independent Commuter Runway 2500' from RWY 121/30R				8 **	94	154	617	139	228	913
(1b) Alternate 2: New Dependent Commuter Runway 1400' from RWY 12L/30R				7.8**	84	137	577	124	203	853
(1c) Alternate 3: New Independent Air Carrier Runway Parallel to RWY 12L/30R				30.0**	132	203	693	195	300	1025
(2) Convert Taxiway F to VFR RWY 13/31	Master Plan	Near Term	Airport Authority	0.9	21	37	313	30	55	463
(3) Angled Exits on RWY 12L/30R	Master Plan	Intermediate	Airport Authority	2.5	1.7	2.8	27	2.5	4.1	40
(4) Taxiway Extensions										
(4a) Extend Taxiway A-South to End of RWY 30L	Achievable	Near Term	Airport Authority	3.0	12			18		
(4b) Extend Taxiway P from Taxiway C to Taxiway M	Achievable	Near Term	Airport Authority	1.3	11			16		
(4c) Extend Taxiway C from Taxiway F to RWY End 24	Master Plan	Intermediate Term	Airport Authority	2.0	14	17		20	26	
(5) Realign Taxiway B off A to RWY 12R/30L	Achievable	Near Term	Airport Authority	(*)	(–)					
(6) Establish Queuing Areas at Various RWY Ends	Achievable	Near Term	Airport Authority	7.5	(–)					
(7) Relocate Cargo Area	Achievable	Near Term	Airport Authority	2.0	3.0			4.5		
(8) Relocate Mid Coast Aviation to Northeast	Achievable	Completed	Airport Authority	(*)	(–)					
(9) Install Marker Lights and Parking Lanes in Center Field Remote Holding Area	Achievable	Near Term	Airport Authority	0.1	(–)					

FIGURE 1

RECOMMENDED OPTIONS AND ANNUAL SAVINGS (Continued)

IMPROVEMENTS	Type of Action *1	Time Frame *2	Responsible Agency	Estimated Construction Costs 1987 Dollars (Millions)	ANNUAL SAVINGS IN THOUSANDS OF HOURS			ANNUAL SAVINGS IN MILLIONS OF 1987 DOLLARS		
					Baseline	Future 1	Future 2	Baseline	Future 1	Future 2
FACILITY AND EQUIPMENT										
(10) Wake Vortex System	Achievable	Far Term	FAA	.5	8	12	86	12	18	127
(11) Install CAT III ILS to Reduce Approach Minima on RWY's 12L and 30R	Achievable	Intermediate	FAA	1.5	0.3	0.3	0.4	0.4	0.5	0.6
(12) IFR Approaches with Additional Instrumentation on RWY 6	Achievable	Intermediate	FAA	.6	(+)					
(13) IFR Approaches with Additional Instrumentation on (RAIL) on RWY 24	Achievable	Near Term	FAA	.2	(+)					
(14) LDA Approaches Support										
(14a) Equipment Installation on RWY 30L	Achievable	Near Term	FAA	.5	6.5	7.8	7.6	9.6	11	11
(14b) Equipment Installation on RWY 12L	Achievable	Near Term	FAA	.6	5.6	6.8	6.5	8.3	10	9.7
(15) Install Light Systems at Taxiway and Runway Intersections	Achievable	Near Term	Airport Authority	(*)	(−)					
(16) Install ASDE	Achievable	Intermediate	FAA	1.0	(−)					
OPERATIONAL IMPROVEMENTS										
(17) Reduce IFR Parallel Approach Stagger to 2 NM	Achievable	Intermediate	FAA	(*)	29	35	57	44	52	84
(18) Reduce IFR Intrail Seperations to 2.5NM	Achievable	Near Term	FAA		11	12	20	16	18	30
(19) Converging IFR Approaches to										
(19a) RWYs 6 and 30R	Achievable	Intermediate	FAA		30	37	58	44	54	86
(19b) RWYS 6 and 30L	Achievable	Intermediate	FAA		31	40	59	46	59	89
(20) Converging IFR Approaches to										
(20a) RWYs 24 and 30R	Master Plan	Intermediate	FAA		32	38	55	47	57	82
(20b) RWYs 24 and 30L	Master Plan	Intermediate	FAA		22	27	41	32	39	60
(21) Simultaneous Approaches to ILS 30R, LDA 30L, and ILS 24	Achievable	Near Term	FAA		75	99	167	111	146	247

FIGURE 1 (Continued)

RECOMMENDED OPTIONS AND ANNUAL SAVINGS (Continued)

IMPROVEMENTS	Type of Action *1	Time Frame *2	Responsible Agency	Estimated Construction Costs 1987 Dollars (Millions)	ANNUAL SAVINGS IN THOUSANDS OF HOURS			ANNUAL SAVINGS IN MILLIONS OF 1987 DOLLARS		
					Baseline	Future 1	Future 2	Baseline	Future 1	Future 2
USER IMPROVEMENTS										
(22) Change Fleet Mix	Major Policy Change	Intermediate Term	Airport Authority/ GA Users							
(22a) Relocate GA 25%				(*)	21	28	95	30	41	141
(22b) Relocate GA 50%				(*)	37	51	171	55	76	252
(22c) Relocate GA 75%				(*)	50	72	244	74	107	361
(23) Distribute Scheduled Commercial Operations Within the Hour	Major Policy Change	Near Term	Airlines	(*)	20	30	78	30	44	116
(24) Relocate Air National Guard	Major Policy Change	Intermediate Term	Airport Authority/ DOD	(*)	3.3	4.8	24	4.9	7.1	35

- 1: Types of Action: *Achievable*—Changes or improvements for which benefits have been clearly identified; on which action may already be underway; and which do not require a major policy change by the responsible agency.
  Major Policy Change—A change in procedure or operational regulation which requires a major policy revision by the responsible agency.
  Master Plan Study—A physical change for which the benefits in delay reduction must be evaluated in terms of its economic and environmental consequences by groups outside the Task Force.
- 2: Time Frame: Improvement available and producing benefits by Future 1 (near term), Future 2 (intermediate term) or beyond Future 2 (far term).

Baseline, Future 1 and Future 2 reflect demand levels of 530,000, 585,000 and 740,000 annual aircraft operations respectively.

* Costs not available.

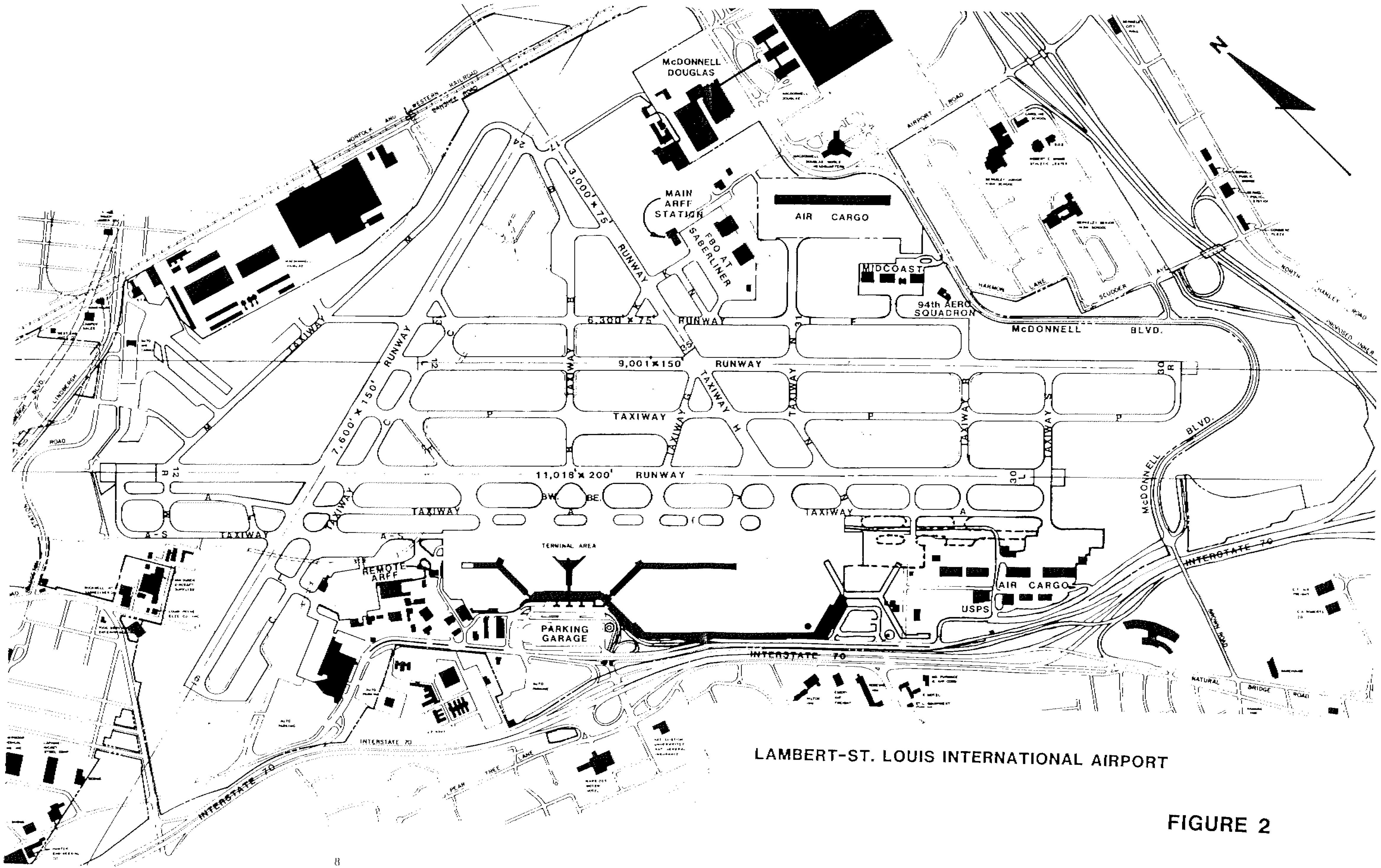
(−) Annual Savings not directly attributable to this improvement

** Costs do not include real estate purchase costs. Final costs will be subject of master plan and economic studies which are beyond the scope of this effort.

(+) Annual Savings included under "operational improvements"

Note: Both costs and savings presented here are non additive.

FIGURE 1 (Continued)



LAMBERT-ST. LOUIS INTERNATIONAL AIRPORT

FIGURE 2

RECOMMENDED OPTIONS

Based on the data developed in this study, the St. Louis Task Force recommends the improvements listed in Figure 1 as "Recommended Options" to meet anticipated growth in demand without excessive delays. Figure 2 shows current layout to which recommended improvements will be added.

Figure 1 also shows the annual delay savings in hours and dollars for each improvement studied by the Task Force for the periods Baseline, Future 1 and Future 2. Baseline, Future 1 and Future 2 refer to annual aircraft operations demand levels of 530,000, 585,000, and 740,000 respectively. Benefits are not necessarily additive.

The proposed recommendations for increasing airport capacity and reducing aircraft delays at STL are categorized and discussed under the following four headings:

- Airfield Improvements.
- Facilities and Equipment Improvements.
- Air Traffic Control Operational Improvements.
- Airport User Improvements.

Airfield Improvements

1. New Runway parallel to Runway 12L/30R. Three alternatives are under consideration to construct a new runway parallel to runway pair 12L/30R and 12R/30L. A new runway is considered primarily on the north side, even though feasibility might include its placement on the South Side of the airfield complex. These alternatives will affect the relocation of existing facilities on or off the airport and real estate purchase. These alternatives will also be Subject of the Master Plan Study and future economic studies.

(a) Alternate 1: A new 6000 foot *independent* commuter runway 2500' north of and parallel to runway 12L/30R. Estimated 1987 construction costs of $8 million. Final costs will be Subject of the Master Plan Study and future economic studies. Estimated annual savings at Baseline activity level are 94,000 hours amounting to $139 million.

(b) Alternate 2: A new 6000 foot *dependent* commuter runway 1400' north of and parallel to runway 12L/30R. Estimated 1987 construction costs of $7.8 million. Final costs will be Subject of Master Plan Study and future economic studies. Estimated annual delay savings at Baseline activity level are 84,000 hours amounting to $124 million.

(c) Alternate 3: A new 11000 foot *independent air carrier* runway parallel to runway 12L/30R. Estimated 1987 construction costs only of $30 million. Final costs will be Subject of Master Plan and future economic studies. Estimated annual delay savings at Baseline activity level are 132,000 hours amounting to $195 million.

2. Convert taxiway F to VFR runway 13/31. This taxiway has been used as a runway for over a year with very good success. Formal (permanent) conversion to a runway will be Subject of the Master Plan Study. Estimated 1987 cost is $0.9 million. Estimated annual delay savings at the Baseline activity level are 21,000 hours amounting to $30 million.

3. Angled exits on runway 12L/30R would reduce runway occupancy time. Estimated 1987 cost is $2.0 million. Estimated annual delay savings at the Baseline activity level are 1,700 hours amounting to $2.5 million.

4. Three major taxiway extensions parallel to runway pairs 12R/30L and 12L/30R and runway 6/24. This would provide better access to the runways, allow more efficient queuing of aircraft for departure and reduce ramp congestion thereby allowing speedy access to gate.

(a) Taxiway A-South extension to end of runway 30L will provide a second parallel taxiway along the main terminal complex. This extension will relieve congestion at the gates and permit two way flow. Additionally, it will hold departures at 30L end. Estimated 1987 cost is $3.0 million. Estimated annual delay savings at the Baseline activity level are $18 million.

(b) Taxiway P extension from taxiway C to taxiway M will provide additional two way access to General Aviation and allow for queuing on the west end of the airport. Estimated 1987 cost is $1.3 million. Estimated annual delay savings at the Baseline activity level are $16 million.

(c) Taxiway C extension from taxiway F to approach end of runway 24 will improve overall movement in the northwest area. Estimated 1987 cost is $2.0 million. Estimated annual delay savings at the Baseline level are $20 million.

5. Realign taxiway B south of runway 12R/30L. This will reduce pilots' confusion when crossing the runway. Two way traffic should be maintained in this area. Access to and from the gate area will be greatly improved.

6. Establish queuing areas at runway ends 24, 12L, 30R. Estimated 1987 cost is $7.5 million.

7. Relocate west cargo area to the north side of the airport. This is a more central location that will allow better access to the runway-taxiway system by cargo aircraft. It will also prevent derogation of ILS signals. Estimated 1987 cost is $2.0 million. Estimated annual delay savings at the Baseline level are $4.5 million.

8. Mid Coast Aviation relocation to northeast has been completed. This allows expansion of the apron and taxiway "A" south.

9. Centerfield holding area upgrading will help to maximize holding capacity. Estimated 1987 cost is $0.1 million.

Facility and Equipment Improvements

10. Expedite development and implementation of wake vortex forecasting and avoidance systems. These systems will increase capacity by permitting reduced longitudinal spacing between aircraft when wake vortices present no hazards to following aircraft. Under current conditions, controllers cannot detect the presence of wake vortices. Therefore, to guard against these potential hazards, they maintain increased separations between aircraft. Estimated 1987 cost is $.5 million. Estimated annual delay savings at the Baseline level are 8000 hours amounting to $12 million.

11. Install CAT III ILS system to enable STL to continue operations during extremely low visibility conditions. Equipment to be installed on both runways 12L and 30R. Siting constraints will have to be resolved before installation. Estimated 1987 cost is $1.5 million. Estimated annual delay savings at the Baseline level are 300 hours amounting to $0.4 million.

12. Install precision approach systems on runway 6. This installation will lower landing minimums on runway 6 below the present RNAV or back course minimums. This installation will also support converging approaches during IFR weather with RWYs 30R and 30L. Estimated 1987 cost is $.65 million.

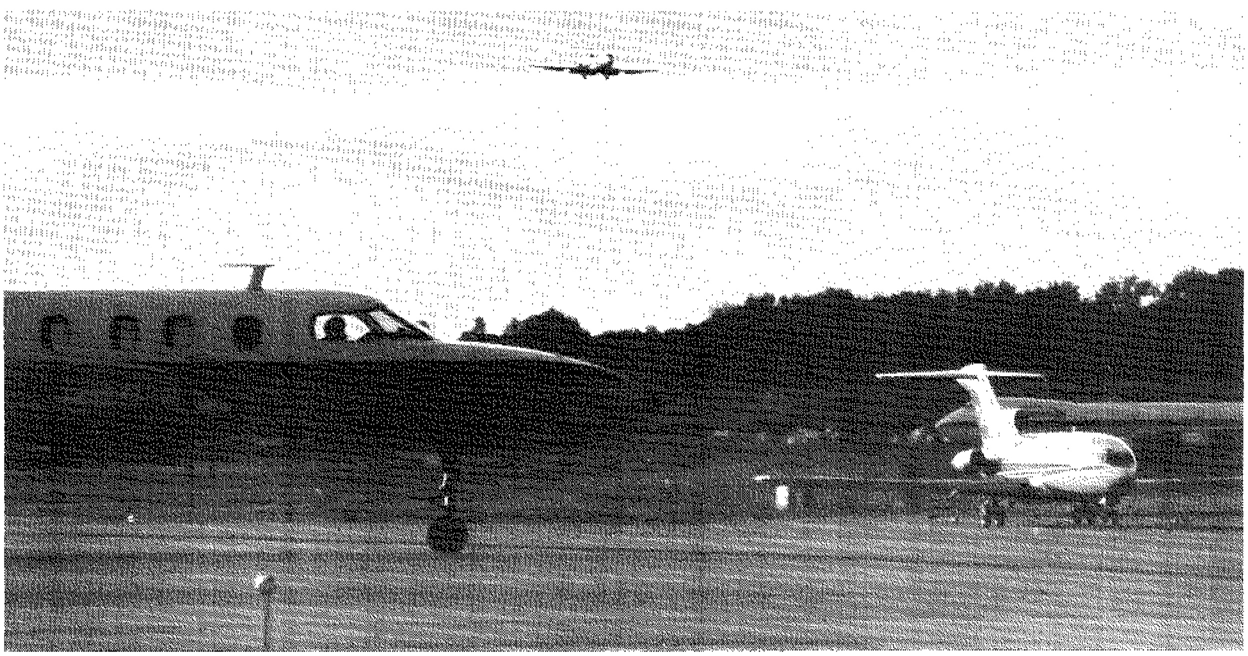
13. Install runway alignment indicator lights (RAIL) and centerline lights on runway 24. These lights will lower the approach minimums from the present 250' and 3/4 mile to 200' and 1/2 mile. This will support converging approaches during IFR weather with RWYs 30R and 30L. Estimated 1987 cost is $.2 million.

14a. Installation of Localizer Directional Aid (LDA), DME and VASI on runway 30L. This installation, a mirror image of that already operational on runway 12L will be used to conduct simultaneous approaches with runway 30R. Estimated 1987 cost is $.5 million. Estimated annual delay savings at the Baseline level are 6,500 hours amounting to $9.6 million.

14b. Installation of lead-in lights on runways 12L and 30L LDA's. One of the limiting factors in reducing the visibility minimums required to conduct LDA approaches is the need to provide positive visual guidance from the missed approach point (MAP) to the runway threshold (the visual segment of the approach). Visual guidance provided by the Runway Alignment Indicator Lights (RAIL) and "eyeballing" of the visual approach flight path segment allows approaches to visibilities of 4 miles or greater. With less than 4 miles, a lead-in light system, consisting of multiple strobe lights beginning near the missed approach point (MAP) and continuing to the beginning of the RAIL, are necessary to provide the pilot with positive flight path definition from the missed approach point (MAP) to a point where the runway approach environment is clearly visible. Further analysis is required to determine the configuration and minimums obtainable. Estimated 1987 cost is $.65 million. Estimated annual delay savings at the Baseline level are 5,600 hours amounting to $8.3 million.

15. Install flashing amber light systems as appropriate at taxiway and runway intersections to provide an additional alerting device. This would help prevent inadvertent runway incursions.

16. Installation of Airport Surface Detection Equipment (ASDE). During very low ceiling and/or visibilities, the tower is unable to visually monitor ground movements on the ramps, runways, and taxiways. When these conditions exist, the orderly flow of ground traffic can only be maintained by greatly restricting traffic movement. The ASDE is a very short range, high resolution radar which will permit the ground traffic to be monitored and controlled on radar much the same way as air traffic is monitored and controlled. This installation will greatly enhance traffic movement under the aforementioned weather conditions. Estimated 1987 cost is $1.0 million.



Operational Improvements

Operational improvements will be made possible by installation of facilities and equipment as well as feasible procedural changes in the terminal air traffic control system. These savings have their primary benefit in adverse weather i.e., instrument flight rule weather (IFR) or weather just above this level as marginal. By way of these improvements a reduction of arrival delay should occur due to the capability to operate with reduced separation minimums or different combinations of runways than presently available during IFR weather conditions. These improvements may be implemented either independently, alternately or in combination. However, savings presented are not cumulative. This feasibility is explored for five improvements identified as items 17, 18, 19, 20 and 21.

17. Reduce present minimum separation of three miles on parallel runways to two miles minimum. This will increase the acceptance rate of the airport during these operations. Estimated annual delay savings at the Baseline level are 29,000 hours amounting to $44 million.

18. Reduce arrival in trail separations to 2.5 nm between similar class, non heavy aircraft. Reducing longitudinal separation on final approach from 3.0 nm to 2.5 nm for these aircraft will increase the arrival acceptance rate and reduce delays. Estimated annual delay savings at the Baseline level are 11,000 hours amounting to $16 million.

19. Converging approaches during IFR weather to: (a) runways 6 and 30R and (b) runways 6 and 30L. Estimated annual delay savings at the Baseline activity level for improvements (a) and (b) are 30,000 hours amounting to $44 million and 31,000 hours amounting to $46 million respectively. This will be supported by installation of ILS equipement (Items 11 and 12).

20. Converging approaches during IFR weather to: (a) runway 24 and 30R and; (b) runway 24 and 30L. Estimated annual delay savings at the Baseline activity level for improvements (a) and (b) are 32,000 hours amounting to $47 million and 22,000 hours amounting to $32 million respectively. This will be supported by installation of equipment (RAIL Item 13).

21. Simultaneous approaches ILS 30R, LDA 30L and ILS 24. These approaches in conjunction with the LDA 12L, ILS 12R already in place will increase the airport acceptance rate and reduce delays. Additional study will be required before implementation. Estimated annual delay savings at the Baseline activity level are 75,000 hours amounting to $111 million.

Airport User Improvements

Airport user improvements affect airlines and General Aviation including cargo carriers serving Lambert field. These improvements are major policy change issues and require extensive coordination and cooperation between carriers and airport tenants. However, the benefits are large enough to attempt implementation of these improvements.

22. Change in fleet mix. Increased delays have resulted from mixing aircraft with different operating characteristics.

The task force has identified the relocation of general aviation traffic as one means for the possible reduction of delays at Lambert Field. Reductions in traffic count of (a)twenty-five, (b)fifty, and (c)seventy-five percent annually were investigated. Whereas the simulations assumed an across the board homogeneous reduction in general aviation traffic count it must be noted that in large part general aviation aircraft are purposely operated at times outside of air carrier scheduling peaks. Consequently, it is recognized that these percentage reductions may not impact delays to the extent suggested by the simulation. Estimated annual delay savings at the Baseline activity level for fifty percent GA relocation will be 37000 hours and $55 million.

Of specific interest, as it relates to the effect of general aviation on overall Lambert Field traffic, is the separation of those general aviation aircraft which are compatible with air carrier aircraft (due to approach speeds, takeoff performance, etc.) and those aircraft which are incompatible. A corporate jet or turboprop normally operates in a fashion which is compatible with carrier aircraft. Other aircraft such as single engine light aircraft are not capable of operating in this compatible fashion. If general aviation is to be relocated away from Lambert Field for the purpose of improving delay statistics, it is important to separate general aviation aircraft into these two categories and hence relocate those which are incompatible on a much larger scale than those which would be compatible. It should be noted that the "incompatible" aircraft represent about 2% of the total traffic and normally do not fly when the weather is IFR, when their presence causes the greatest delay.

23. Uniformly distribute scheduled commercial operations within the hour. More uniform scheduling for both arrivals and departures within the peak hours will produce a more orderly flow of traffic on the airport surface and reduce congestion. Theoretically, this offers the potential for immediate reduction of delays, provided flights are allowed to operate as scheduled by Central Flow Control not only in and out of the STL Terminal Area, but in and out of the flight's origin or destination airport. Additionally, STL is a major connecting hub, inherent to which are many variables of an uncertain nature. Estimated annual delay savings at the Baseline activity level are 20,000 hours amounting to $30 million.

24. Relocate Air National Guard. This relocation is anticipated to reduce 5% of the high performance aircraft and may be considered as part of other policy decisions. Guard relocation will be analyzed further in the Master Plan. This case is similar to that concerned with the change in fleet mix through relocations of general aviation in paragraph (22) above. Whereas the simulations assume an across the board homogeneous reduction in Air National Guard (ANG) traffic count, it must be noted that all ANG operations are scheduled on a month to month basis during forecasted non-peak periods. Consequently, the real impact of ANG relocation on delay statistics is likely to be considerably less than the simulations indicate.

Estimated annual delay savings at the Baseline activity level are 3,300 hours amounting to $4.9 million.

SUMMARY OF TECHNICAL STUDIES

The St. Louis Task Force evaluated the operation of the existing airfield and the potential benefits of the improvements in terms of airfield capacity, airfield demand, and average aircraft delays.

The Task Force used the airfield simulation model to determine peak period aircraft delays for current and future operations.

Daily operations corresponding to an average day in the peak month for each of the forecast time periods were used in this study.

Daily delays were annualized to determine the potential economic benefits of the proposed improvements, including different runway use strategies. The annualized delays provide a baseline measurement for comparing the benefits of the proposed changes.

A $24.65 dollar value is attached to each minute of average aircraft annual delay for both present and proposed operations. This dollar figure is the average direct operating cost per minute for the fleet mix at STL and does not consider lost passenger time, disruption to airline schedules or any other intangible factors.

The cost of a particular improvement is measured against its annual delay savings. Thus, a comparison of the costs and delay reductions associated with the proposed improvement indicates which are the most effective in a given time period.

For an anticipated increase in demand, an optimum combination of improvements can be implemented in stages so that airfield capacity is increased and aircraft delays are kept within acceptable limits.

The figures shown on the following pages illustrate airfield weather and runway utilization, and demand levels at Lambert-St. Louis International Airport.

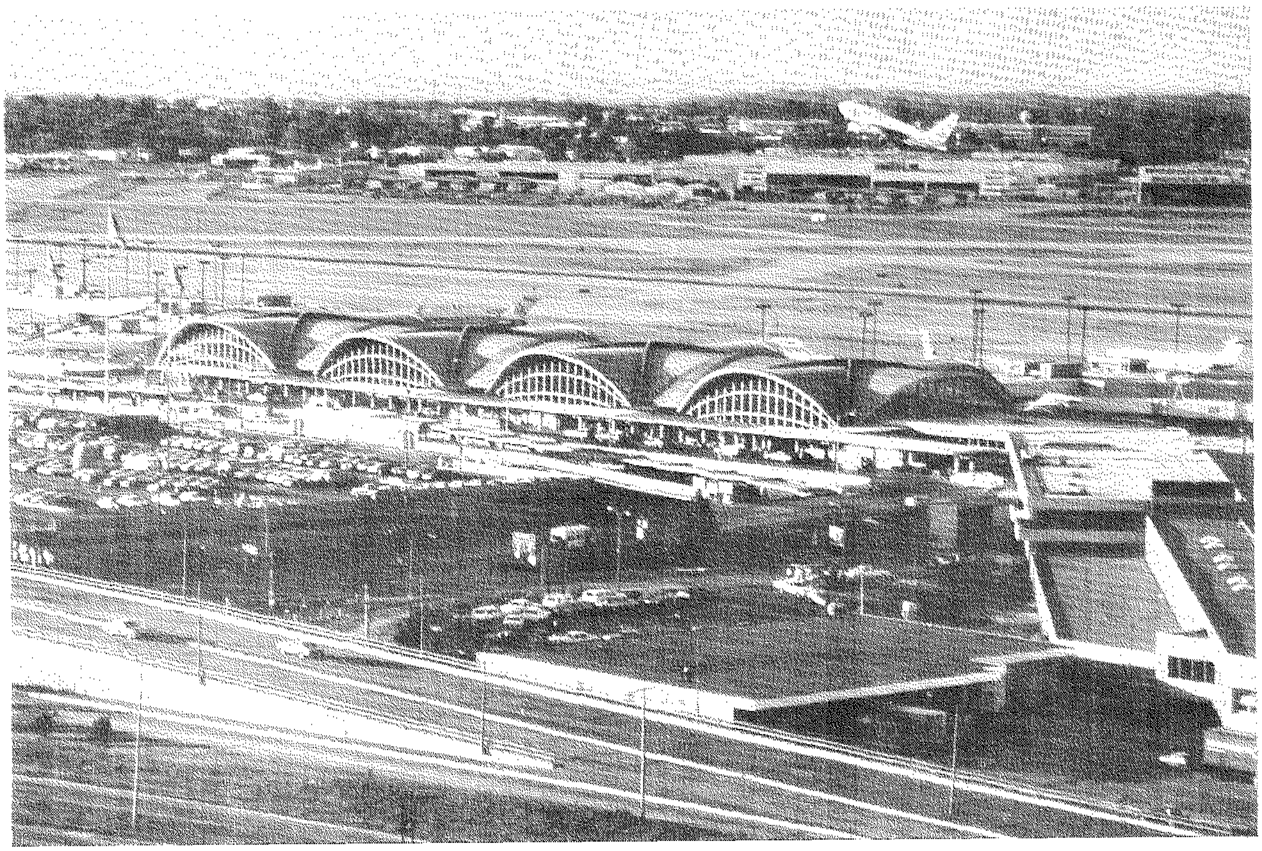


Figure 3
AIRFIELD WEATHER AND RUNWAY UTILIZATION
LAMBERT-ST. LOUIS INTERNATIONAL AIRPORT

Weather	Visibility/Ceiling	Occurrence %
VFR	4 miles/3000 ft. or above	74
IFR/VFR	5 miles/3000 ft. to 4 miles/1500 ft.	11
IFR	Less than 4 miles/below 1500 ft.	15

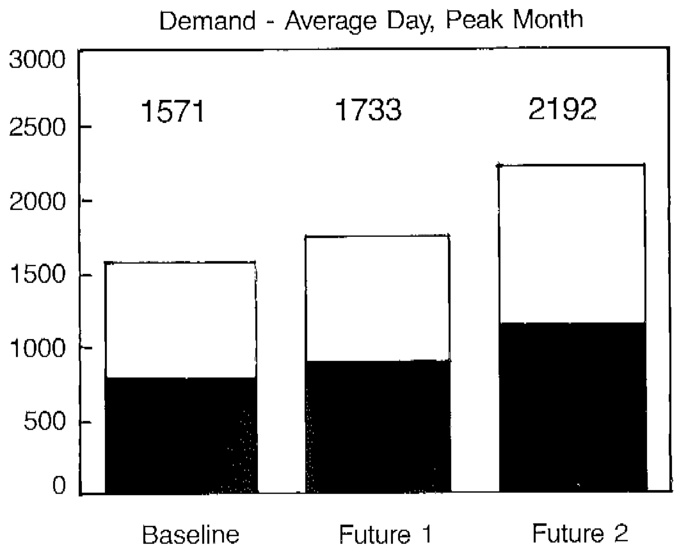
Runway Use	Configuration	Percentage Use		(1987 Baseline)	Total *
		VRF	IFR/VFR	IFR	(All Weather)
1	30R	44	6	11	61*
	30L				
3	12L	30	5	4	39
	12R				
	Total	74	11	15	100

Arrival

Departure

• Runway 6 or 24 are utilized three (3) percent of the time during certain weather conditions.

Figure 4
AIRFIELD DEMAND LEVELS
LAMBERT-ST. LOUIS INTERNATIONAL AIRPORT

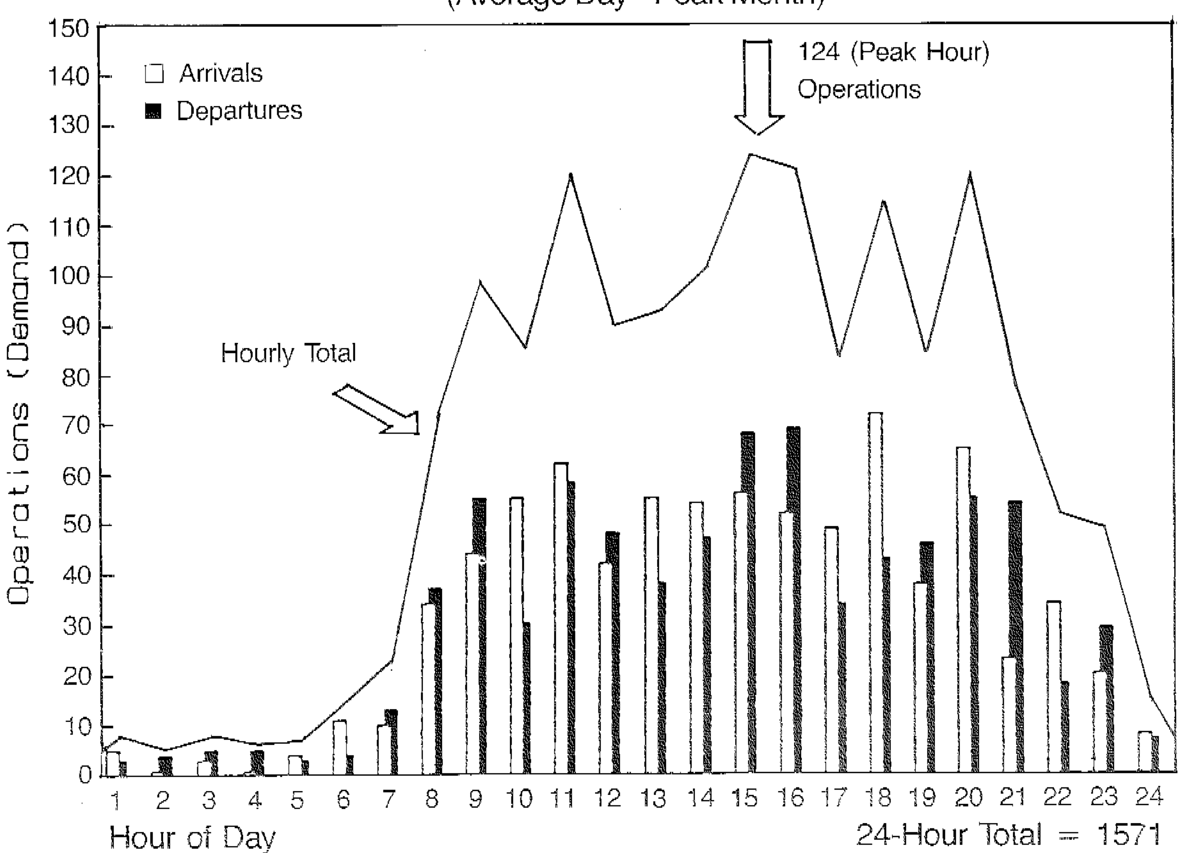


Aircraft Operations

Annual		24-hour day (average day, peak month)	Peak Hour
Baseline	530,000	1571	124
Future 1	585,000	1733	136
Future 2	740,000	2192	175

□ Arrivals
■ Departures

HOURLY VARIATION OF BASELINE DEMAND
(Average Day - Peak Month)



Airfield Capacity

Airfield capacity is the maximum number of aircraft operations (landings or takeoffs) that can take place in a given time under the following conditions: an acceptable level of arrival delay; airspace constraints; ceiling and visibility, runway layout and use; aircraft mix; and percent arrival demand. The capacity results, as illustrated in Figure 5, are expressed in operations per hour for both an average four-minute arrival delay (considered acceptable) and for maximum throughput. Maximum throughput capacity means there is always an arrival or departure aircraft available for every possible slot under ideal weather conditions. This implies a large average delay would be required to achieve the maximum throughput capacity. These values, generated by the Capacity/Delay computer model described in Appendix A, are based on a 50-50 demand split and balanced flow feasible under VFR and IFR/VFR weather conditions.

Figure 5
AIRFIELD CAPACITY ANALYSIS
LAMBERT-ST. LOUIS INTERNATIONAL AIRPORT

		Capacity With Acceptable Delay	Maximum Throughput	
Current Runway Configuration			**Capacity**	**Average Delay (Min)**
30R	VFR	ARR = 59	ARR = 61	45
		DEP = 58	DEP = 60	44
	IFR/VFR	ARR = 47	ARR = 52	41
		DEP = 46	DEP = 51	40
30L	IFR	ARR = 26	ARR = 31	87
		DEP = 28	DEP = 40	62
Future Runway Configuration				
Air Carrier	VFR	ARR = 86	ARR = 91	33
		DEP = 86	DEP = 90	33
30A				
30R	IFR/VFR	ARR = 68	ARR = 77	48
30L		DEP = 68	DEP = 77	48
	IFR	ARR = 47	ARR = 56	40
30A		DEP = 42	DEP = 43	60
30R				
30L				

ARR = ARRIVAL

DEP = DEPARTURE

Aircraft Delays

Aircraft delay is the time over and above the unimpeded travel time taken by an aircraft to move from its origin to its destination due to interference from other aircraft in the system competing for the use of the same facilities.

The major factors influencing aircraft delays are:

- Weather
- Airfield demand
- Airfield physical characteristics
- Air traffic control procedures
- Aircraft operational characteristics

Annual delay cost expressed in millions of dollars for various daily demand levels are shown in figures 6, 7, and 8. These figures present comparisons between "Do Nothing" and:

- Airfield Improvements (Figure 6);
- Facilities & Equipment and Operational Improvements (Figure 7) and;
- Airport User Related Improvements (Figure 8)

The delay costs are estimated for daily demand levels through Future 2. Under the "do nothing" situation, the average delay of 18 minutes per operation at the assumed Baseline of 530,000 annual operations will increase by four times to 70 minutes per operations by Future 2. And, the annual delay cost will increase from $233 million in Baseline to $1283 million by Future 2.

Figure 6
ANNUAL DELAY COSTS
LAMBERT-ST. LOUIS INTERNATIONAL AIRPORT

IMPROVEMENTS: AIRFIELD

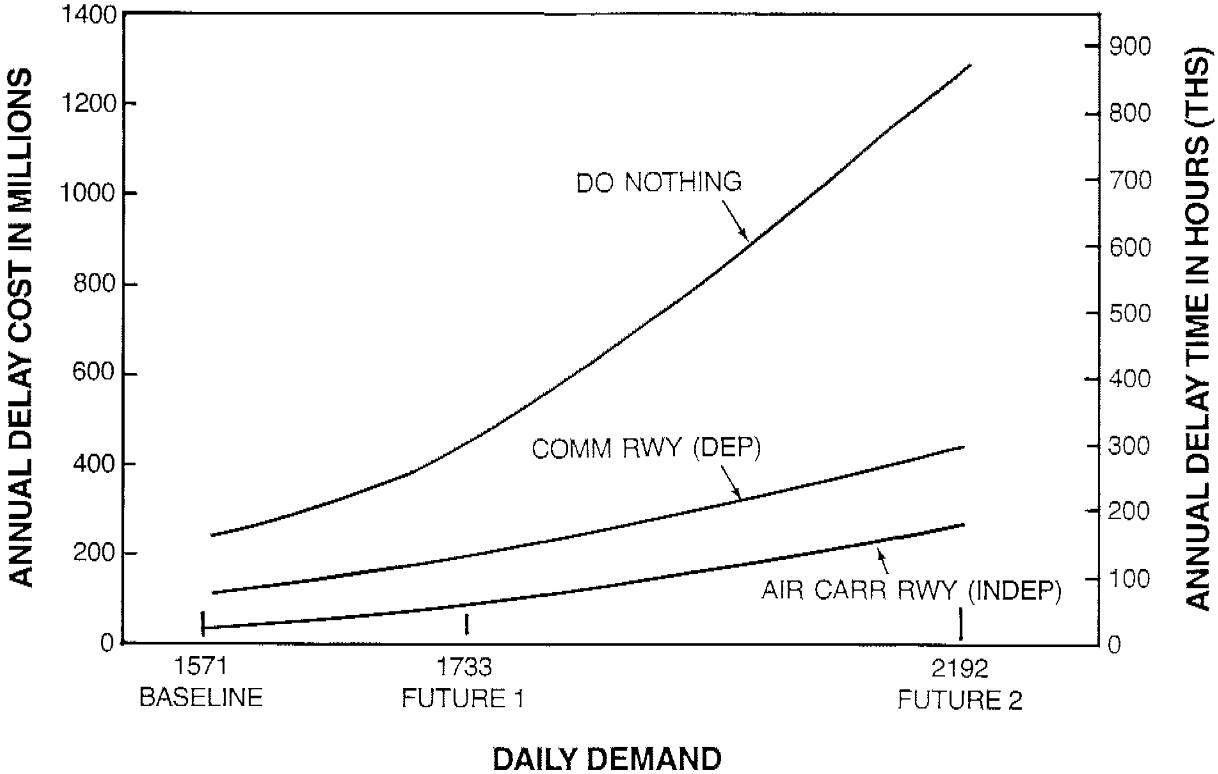


Figure 7
ANNUAL DELAY COSTS
LAMBERT-ST. LOUIS INTERNATIONAL AIRPORT

IMPROVEMENTS: FACILITIES, EQUIPMENT AND OPERATIONAL

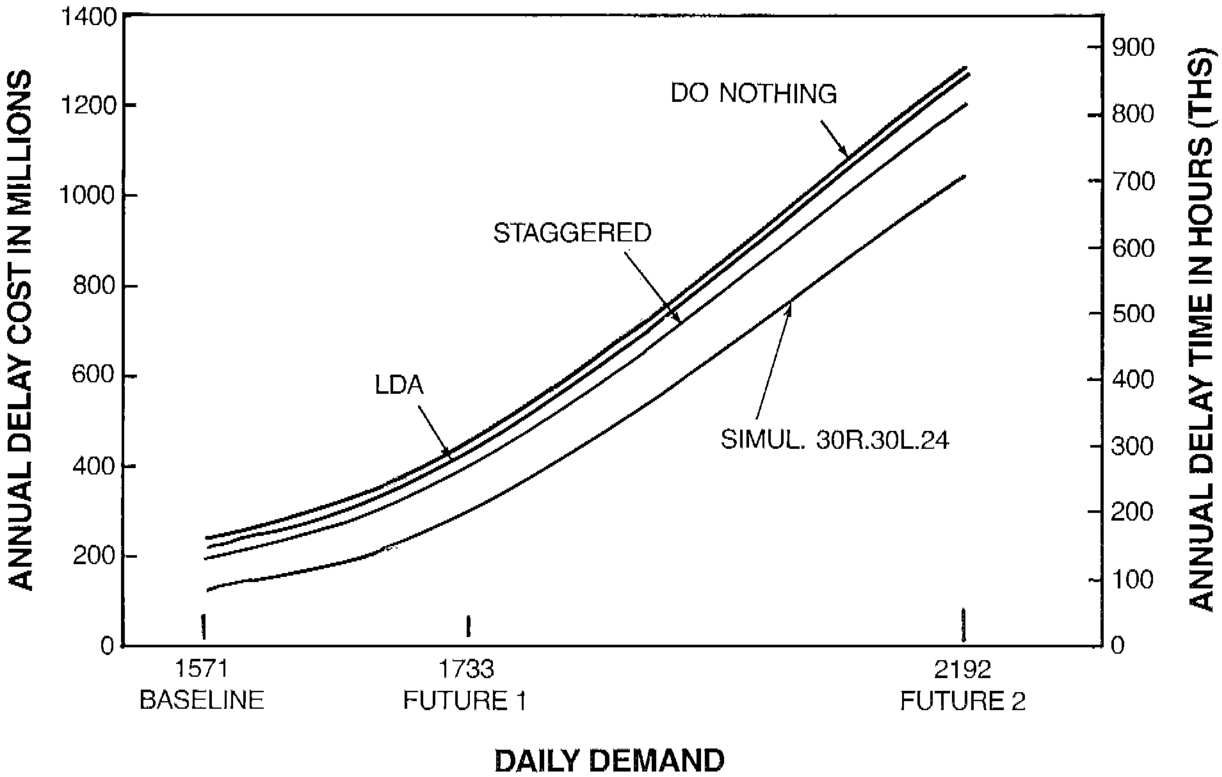
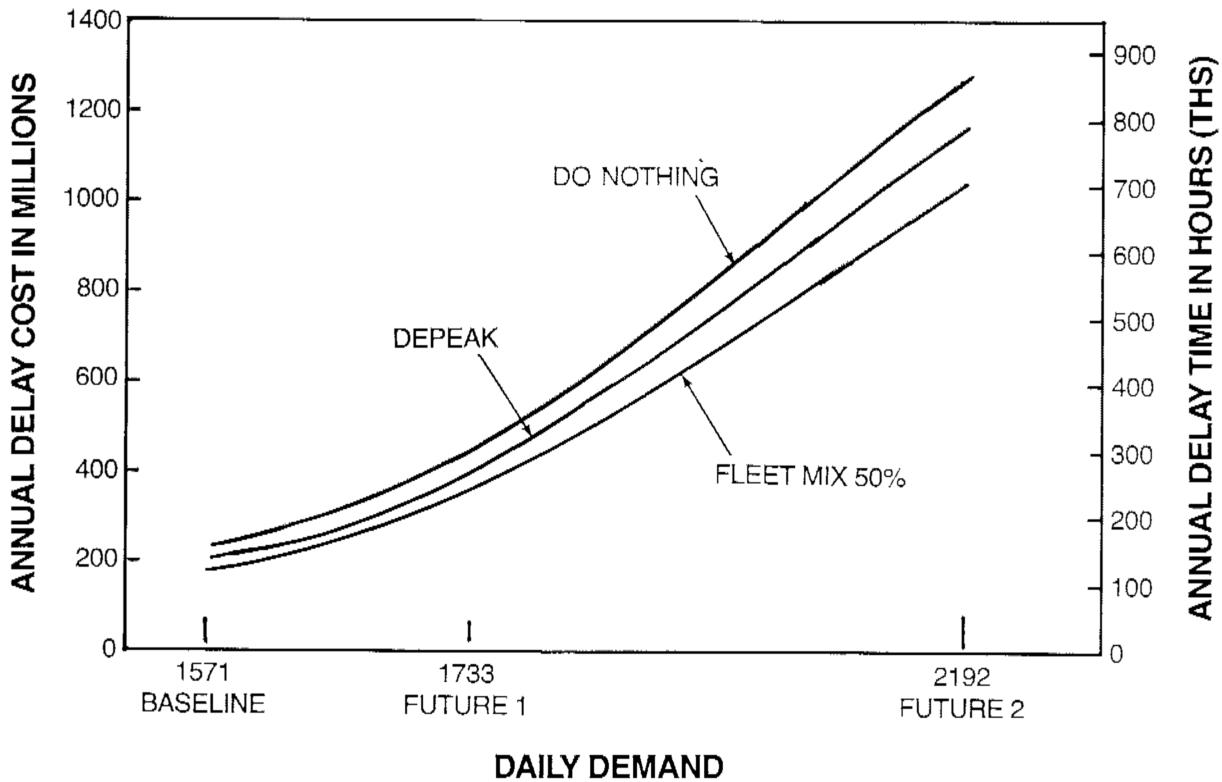


Figure 8
ANNUAL DELAY COSTS
LAMBERT-ST. LOUIS INTERNATIONAL AIRPORT

IMPROVEMENTS: USER



APPENDIX A

Computer Models and Methodology

The FAA studied the effects of proposed delay reduction and capacity increase options on St. Louis International Airport's (STL) anticipated increase in future demands using computer modeling.

Model simulations involved present and future air traffic control procedures, various airfield improvements, and traffic demands for different time frames. To assess projected airfield improvements, the FAA used different airfield configurations derived from present and projected airport layouts. The time frame for air traffic control procedures and system improvements determined the aircraft separations used for IFR and VFR weather simulations.

For the delay analysis, agency specialists developed traffic demands based on the Official Airline Guide, historical data and Task Force forecasts. Aircraft volume, mix and peaking characteristics were developed for three demand periods (Baseline, Future 1 and Future 2) based on the changing nature of the airport. Annual delay estimated for the proposed improvement options were extrapolated from the experimental results. The estimates took into account the yearly variations in runway configurations, weather and demand based on historical data.

The Task Force then compared the annual delay estimates and assessed the potential delay reductions.

Airfield Delay Simulation Model (ADSIM):

This is a fast-time, discrete event model that employs stochastic processes and Monte Carlo sampling techniques. It describes significant movements by aircraft on the airport and the effects of delay in the adjacent airspace. The model was validated in 1978 at Chicago' O'Hare International Airport against actual flow rates and delay data. It was then calibrated for this study against field data collected at STL to insure that the model was site specific.

Inputs for the simulation model were empirically derived from the collected field data. The model repeated each experiment 10 times using Monte Carlo sampling techniques to introduce system variability. The results were then averaged to produce output statistics for total and hourly aircraft delays, travel times and flow rates for the airport and for the individual runways.

Runway Delay Simulation Model (RDSIM):

This is the short form of the Airfield Delay Simulation Model. It simulated demand only for the runways and does not consider the taxiway network nor the terminal complexes. It is suitable for capacity analysis because the majority of airfield delays are runway related.

For a given demand, the model calculated the hourly flow rate and average delay per aircraft during the full period of airport operations. Arrival demand was assumed to equal departure demand, and aircraft were randomly assigned arrival and departure times. Arrivals received priority over departures.

The experiments were repeated 40 times using Monte Carlo sampling techniques to introduce system variability into each run. The results were then averaged to produce the capacity/delay outputs for a given demand level. Using the same aircraft mix, computer specialists simulated different demand levels for each run to generate demand versus delay relationships.

Capacity was calculated for both an average four-minute arrival delay (considered acceptable) and for maximum throughput. The maximum throughput capacities were based on unlimited arrival and departure queues and produced very large delays. Operationally unacceptable, the maximum throughput delays are included for comparison purposes only.

Figure 9 shows the results of both types of calculations and illustrates the severe penalty associated with maximum throughput. The average arrival delay per aircraft is plotted against arrival capacity for one of the VFR runway configurations.

The maximum throughput approach provided a small increase in capacity at a severe increase in delay compared to the four-minute arrival delay.

Both methods yielded relatively close arrival flow rates (59 aircraft per hour versus 61) but generated radically different arrival delays (four minutes versus 45 minutes per aircraft).

Figure 9
AIRPORT DELAY CURVE
LAMBERT-ST. LOUIS INTERNATIONAL AIRPORT

CURRENT RUNWAY CONFIGURATION